PATENT ABSTRACTS OF JAPAN

(11)Publication number : 09-013136
(43)Date of publication of application : 14.01.1997

(51)Int.Cl. C22C 19/00
F16F 1/02
F16F 1/10
G04B 1/14

(21)Application number : 08-102916
(22)Date of filing : 24.04.1996

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(30)Priority
Priority number : 07106410 Priority date : 28.04.1995 Priority country : JP

(54) SPIRAL SPRING AND ITS PRODUCTION

(57)Abstract:
PROBLEM TO BE SOLVED: To produce a spiral spring high in output torque and excellent in durability and corrosion resistance.
SOLUTION: A wire rod obtd. by subjecting a Co-Ni base alloy having a compsn. contg., by weight, 30 to 40% Co, 27 to 36% Ni, 12 to 26% Cr, 8 to 13% Mo, respectively 0.1 to 3% of one or ≥two kinds among Mn, Ti, Al and Fe, 0.5 to 3% Nb and 0.005 to 0.05% misch metal with inevitable impurities to melting by vacuum melting and subjecting the same to cold wire drawing at 30 to 90% final working degree by a reverse tension wire drawing machine is worked into a spiral spring by using a material subjected to cold rolling and is thereafter subjected to aging treatment at 400 to 620° C in a vacuum or in a nonoxidizing atmosphere.

LEGAL STATUS

[Date of request for examination] 06.03.1997

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

CLAIMS

[Claim(s)]
[Claim 1] Spiral spring characterized by using work hardening and an age-hardening mold Co-nickel radical alloy.
[Claim 2] A presentation is spiral spring characterized by using one sort of 30 - 40% of Co(es), 27 - 36% of nickel, 12 - 26% of Cr(s), 8 - 13% of Mo, and Mn, Ti, aluminum and Fe or two or more sorts of each 0.1 - 3%, 0.5 - 3% of Nb(s), 0.005 - 0.05% of misch metals, and the Co-nickel radical alloy that consists of an unescapable impurity by the weight ratio.
[Claim 3] A presentation is spiral spring characterized by using the Co-nickel radical alloy which consists of 30.9 - 37.2% of Co(es), 31.4 - 33.4% of nickel, 19.5 - 20.5% of Cr(s), 9.5 - 10.5% of Mo, 0.1 - 0.5% of Mn, 0.3 - 0.7% of Ti, 1.1 - 2.1% of Fe(s), 0.8 - 1.2% of Nb(s), 0.01 - 0.02% of misch metals, and an unescapable impurity by the weight ratio.
[Claim 4] Spiral spring characterized by using the ingredient which cold-rolled the wire rod which carried out wire drawing between the colds of claim 2 and the Co-nickel radical alloy given in 3 any 1 terms to the 30 - 90% of the last workability expressed with the reduction of area.
[Claim 5] A presentation by the weight ratio 30 - 40% of Co(es), 27 - 36% of nickel, 12 - 26% of Cr(s), 8 - 13% of Mo, and one sort or two or more sorts of each 0.1 - 3% of Mn, Ti, aluminum and Fe In the process which manufactures spiral spring using 0.5 - 3% of Nb(s), 0.01 - 0.02% of misch metals, and the Co-nickel radical alloy that consists of an unescapable impurity The manufacture approach of the spiral spring characterized by an annealing process, the wire-drawing process between the colds, a cold rolling process, a ****** process, an edge polish process, a cutting process, a forming cycle, an aging treatment process, and a welding operator having a Teflon vacuum evaporationo process at least.
[Claim 6] A presentation by the weight ratio 30.9 - 37.2% of Co(es), 31.4 - 33.4% of nickel, 19.5 - 20.5% of Cr(s), 9.5 - 10.5% of Mo, 0.1 - 0.5% of Mn, In the process which manufactures spiral spring using 0.3 - 0.7% of Ti, 1.1 - 2.1% of Fe(s), 0.8 - 1.2% of Nb(s), 0.01 - 0.02% of misch metals, and the Co-nickel radical alloy that consists of an unescapable impurity The manufacture approach of the spiral spring characterized by an annealing process, the wire-drawing process between the colds, a cold rolling process, a ****** process, an edge polish process, a cutting process, a forming cycle, an aging treatment process, and a welding operator having a Teflon vacuum evaporationo process at least.
[Claim 7] The manufacture approach of the spiral spring characterized by having the process which prepares the wire rod which carried out wire drawing between the colds to the 30 - 90% of the last workability expressed with the reduction of area by drawing out the annealed wire rod in the production process of spiral spring claim 5 and given in 6 any 1 terms, and carrying out wire-drawing processing with a back tensioned drawing machine using a dice.
[Claim 8] It is the manufacture approach of the spiral spring characterized by processing an aging treatment process in a vacuum or nonoxidizing atmosphere at the temperature of 400-620 degrees C in the production process of spiral spring claim 5 and given in 6 any 1 terms.
DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention -- the power of a small precision mechanical equipment, for example, a wrist watch, -- it is related with spiral spring and its manufacture approach.
[0002]
[Description of the Prior Art] the power of a wrist watch -- since a high output torque and endurance, and corrosion resistance are required of spiral spring, high elasticity and Co radical alloy of a high corrosion resisting material are used for the ingredient.
[0003]
[Problem(s) to be Solved by the Invention] The output torque of spiral spring is expressed with the following formula.
T=Ebt3piN/6LT:output-torque E: -- Young's modulus b: of an ingredient -- width-of-face t: of spiral spring -- thickness N: of spiral spring -- number-of-active-coils L: of spiral spring -- the die length of spiral spring -- the thickness of spiral spring -- Although what is necessary is just to use an ingredient with high Young's modulus for obtaining a high output torque, without increasing width of face the power for wrist watches excellent in the endurance which the Young's modulus of Co radical alloy currently used conventionally is 2 20000 to 21000 kgf/mm, and has Young's modulus higher than this, and corrosion resistance -- spiral spring -- the ingredient was called for.
[0004]
[Means for Solving the Problem] In order to solve said technical problem, in this invention, the quality of the material of spiral spring was used as the Co-nickel radical alloy which has a high mechanical strength and Young's modulus, the outstanding endurance, and corrosion resistance. As for a presentation, this Co-nickel radical alloy shows one sort of 30 - 40% of Co(es), 27 - 36% of nickel, 12 - 26% of Cr(s), 8 - 13% of Mo, and Mn, Ti, aluminum and Fe or two or more sorts of each 0.1 - 3%, 0.5 - 3% of Nb(s), 0.005 - 0.05% of misch metals, and the Co-nickel radical alloy that consists of an unescapable impurity by the weight ratio.
[0005] The reason limited to the Co-nickel radical alloy which contains 30 - 40% of Co(es) and 27 - 36% of nickel here is that there is no OFF chip brittleness and it excels in a mechanical strength, fatigue strength, corrosion resistance, and workability. If a mechanical strength falls [Co] at less than 30% and Co exceeds 40%, it becomes hard, and cold-working nature falls and is unsuitable.
[0006] The reason for having made nickel into 27 - 36% is because the optimal range which maintains a mechanical strength and workability is shown. Although Fe also has the same effectiveness as nickel, it is made this range in order not to reduce corrosion resistance. Since the reason of 12 - 26% of Cr(s) and 8 - 13% of Mo shows the optimal range which has corrosion resistance in the conditions containing Co and nickel, it will become hard in cold working if corrosion resistance is inferior in it at under this minimum and this upper limit is exceeded, and it becomes processing difficulty, it is based on an unsuitable thing. Mn helps softening of a matrix on the occasion of the effectiveness and solution treatment as a deoxidizer. aluminum has the effectiveness which raises the effectiveness and the mechanical strength as a deoxidizer. Ti has the effectiveness of grain refining. Although there is effectiveness which raises a mechanical strength further, Nb becomes hard too much and is unsuitable if 3% is exceeded. A misch metal has the effectiveness which improves hot-working nature.

[0007] This alloy is ingoted in vacuum melting and wire drawing between the colds is carried out to the 30 - 90% of the last workability expressed with the reduction of area after forging, hot rolling, wire drawing between heat, solution treatment, wire drawing between the colds, and annealing. Since it is hard and deformation resistance is large, this alloy is drawn out, and it carries out wire drawing with a back tensioned drawing machine using a dice. The wire rod is cold-rolled in the predetermined thickness of spiral spring. A wire rod is rolled out here because the rolling direction of an ingredient can make the output torque of a set and spiral spring still higher by this in the direction where the Young's modulus of a crystal is high.
[0008] The wire-drawing last workability was made into 30% or more because it was good that the rolling direction of an ingredient shows the lower limit in which the effectiveness of making a set and the output effectiveness of a spiral spring still higher shows up in the direction where the Young's modulus of a crystal is high, and made the wire-drawing last workability 90% or less in it even if the toughness of spiral spring falls if workability becomes higher than this. Thus, finished rolled stock is ******(ed) to predetermined width of face, and spiral spring is made through each process of edge polish, cutting, shaping, aging treatment, welding, and Teflon vacuum evaporationo. Aging treatment is performed in a 2 - 3-hour vacuum, or nonoxidizing atmosphere at the temperature of 400-620 degrees C.
[0009] drawing 1 -- the power for wrist watches -- the example of a configuration of spiral spring -- moreover, the example of the production process of spiral spring is shown in drawing 2 .
[0010]
[Function] By the above configurations, it has a high output torque and the spiral spring excellent in endurance and corrosion resistance can be obtained.
[0011]
[Example] a Co-nickel radical alloy (alloy A) and the former -- Co radical alloy (alloy B) of use -- using -- the power for wrist watches -- it was processed into spiral spring and the property was compared. The presentation of Alloy A and Alloy B is shown in Table 1 and Table 2, respectively. Moreover, the Young's modulus of Alloy A and Alloy B is shown in Table 3.
[0012]
TECHNICAL FIELD

[Industrial Application] this invention -- the power of a small precision mechanical equipment, for example, a wrist watch, -- it is related with spiral spring and its manufacture approach.

PRIOR ART

[Description of the Prior Art] the power of a wrist watch -- since a high output torque and endurance, and corrosion resistance are required of spiral spring, high elasticity and Co radical alloy of a high corrosion resisting material are used for the ingredient.
EFFECT OF THE INVENTION

[Effect of the Invention] it explained above -- as -- this invention -- the output torque of spiral spring is high, and since it excels in endurance and corrosion resistance, it is used for a small precision mechanical equipment, and has the big effectiveness of

being the optimal.
TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] The output torque of spiral spring is expressed with the following formula.
T=Ebt3piN/6LT:output-torque E: -- Young's modulus b: of an ingredient -- width-of-face t: of spiral spring -- thickness N: of spiral spring -- number-of-active-coils L: of spiral spring -- the die length of spiral spring -- the thickness of spiral spring -- Although what is necessary is just to use an ingredient with high Young's modulus for obtaining a high output torque, without increasing width of face the power for wrist watches excellent in the endurance which the Young's modulus of Co radical alloy currently used conventionally is 2 20000 to 21000 kgf/mm, and has Young's modulus higher than this, and corrosion resistance -- spiral spring -- the ingredient was called for.

MEANS

[Means for Solving the Problem] In order to solve said technical problem, in this invention, the quality of the material of spiral spring was used as the Co-nickel radical alloy which has a high mechanical strength and Young's modulus, the outstanding endurance, and corrosion resistance. As for a presentation, this Co-nickel radical alloy shows one sort of 30 - 40% of Co(es), 27 - 36% of nickel, 12 - 26% of Cr(s), 8 - 13% of Mo, and Mn, Ti, aluminum and Fe or two or more sorts of each 0.1 - 3%, 0.5 - 3% of Nb(s), 0.005 - 0.05% of misch metals, and the Co-nickel radical alloy that consists of an unescapable impurity by the weight ratio.
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[0007] This alloy is ingoted in vacuum melting and wire drawing between the colds is carried out to the 30 - 90% of the last workability expressed with the reduction of area after forging, hot rolling, wire drawing between heat, solution treatment, wire drawing between the colds, and annealing. Since it is hard and deformation resistance is large, this alloy is drawn out, and it carries out wire drawing with a back tensioned drawing machine using a dice. The wire rod is cold-rolled in the predetermined thickness of

spiral spring. A wire rod is rolled out here because the rolling direction of an ingredient can make the output torque of a set and spiral spring still higher by this in the direction where the Young's modulus of a crystal is high.
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[0009] drawing 1 -- the power for wrist watches -- the example of a configuration of spiral spring -- moreover, the example of the production process of spiral spring is shown in drawing 2 .
OPERATION

[Function] By the above configurations, it has a high output torque and the spiral spring excellent in endurance and corrosion resistance can be obtained.
[Example] a Co-nickel radical alloy (alloy A) and the former -- Co radical alloy (alloy B) of use -- using -- the power for wrist watches -- it was processed into spiral spring and the property was compared. The presentation of Alloy A and Alloy B is shown in Table 1 and Table 2, respectively. Moreover, the Young's modulus of Alloy A and Alloy B is shown in Table 3.
henceforth -- the product made from alloy A -- spiral spring -- this invention -- the product made from spiral spring and alloy B -- spiral spring -- a comparison -- spiral spring will be called. After ingoting each alloy in vacuum melting and passing through each process of forging, hot rolling, wire drawing between heat, solution treatment, wire drawing between the colds, and annealing, the back tensioned drawing machine performed wire-drawing processing of the 60% of the last workability in ordinary temperature using the drawing dice made from superhard, and it was made the wire rod of 3mm of wire sizes. Edge polish was performed, after rolling out the wire rod in thickness of 0.12mm in ordinary temperature and ******(ing) in width of face of 0.95mm.
[0015] next, die length of 370mm -- cutting -- fabrication -- carrying out -- spiral spring -- sotogake was welded to the edge. Aging treatment was carried out in the 2-hour vacuum at 500 degrees C after that, finally vacuum deposition of the Teflon was carried out to the front face, and spiral spring was made. This spiral spring was inserted in the barrel vehicle, and the property of spiral spring was investigated. The bore of a barrel vehicle is 10.60mm and a volume core diameter is 2.80mm.
[0016] The condition that spiral spring 1 was inserted in drawing 3 on the barrel vehicle 3 is shown. The sign 2 in drawing is the sotogake of a spiral spring, and a sign 4 is the barrel heart. Table 4 -- each -- number-of-turns N related to the output torque T0.5 (output torque in the condition of having come loose by 0.5 hour after winding up spiral spring to the limit) of spiral spring, an output torque T24 (output torque in the condition of having come loose by 24 hour), and the persistence time is shown. Table 4 shows -- as -- this invention -- spiral spring -- a comparison -- it is by T0.5 and the output torque is high 18% by T24 15% compared with spiral spring. moreover -- if this is the spiral

spring of the same output torque -- this invention -- spiral spring -- a comparison -- spiral spring -- comparing -- spiral spring -- since thickness can be made thin, the number of turns of spiral spring can be increased in the tooth space of the limited barrel vehicle, and the persistence time of a clock can be developed.

[0017]

Next, in order to investigate the endurance of spiral spring, the accelerated test which repeats all volume bundle all rewinding [of spiral spring] was performed, and the number of repeats until spiral spring fractures was investigated. Table 5 -- this invention -- spiral spring and a comparison -- the number of repeats to fracture of spiral spring is shown. this invention -- spiral spring -- a comparison -- it turns out that many numbers of repeats to fracture are excellent in endurance compared with spiral spring. moreover, this invention -- since spiral spring contains Cr and Mo so much so that it may understand, even if it sees an ingredient presentation, corrosion resistance is also very excellent.

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報（Ａ）**　(11)特許出願公開番号

特開平9－13136

(43)公開日　平成９年(1997)１月14日

(51)Int.Cl.[6]	識別記号	庁内整理番号	ＦＩ		技術表示箇所
Ｃ２２Ｃ　19/00			Ｃ２２Ｃ　19/00	Ｚ	
Ｆ１６Ｆ　1/02			Ｆ１６Ｆ　1/02	Ａ	
1/10			1/10		
Ｇ０４Ｂ　1/14			Ｇ０４Ｂ　1/14		

審査請求　未請求　請求項の数８　ＯＬ　（全５頁）

(21)出願番号　特願平8－102916

(22)出願日　平成８年(1996)４月24日

(31)優先権主張番号　特願平7－106410

(32)優先日　平７(1995)４月28日

(33)優先権主張国　日本（ＪＰ）

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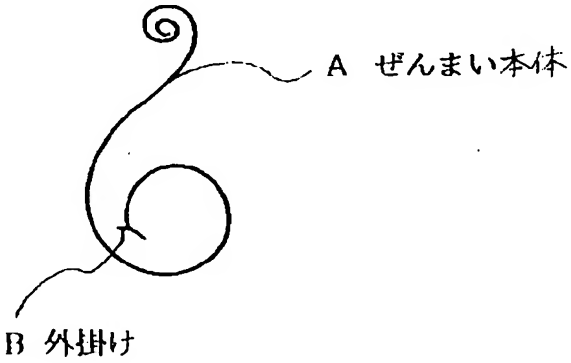
最終頁に続く

(54)【発明の名称】　ぜんまいおよびぜんまいの製造方法

(57)【要約】

【課題】　小型精密機器、例えば、腕時計用の動力ぜんまいとその製造方法の発明であり、出力トルクが高く、耐久性及び耐食性に優れたぜんまいを提供する。

【解決手段】　組成は重量比でＣｏ３０～４０％、Ｎｉ２７～３６％、Ｃｒ１２～２６％、Ｍｏ８～１３％、Ｍｎ、Ｔｉ、Ａｌ、Ｆｅの１種または２種以上各０．１～３％、Ｎｂ０．５～３％、ミッシュメタル０．００５～０．０５％、及び不可避不純物から成るＣｏ－Ｎｉ基合金を真空溶解にて溶製し、逆張力伸線機で最終加工度３０～９０％に冷間線引した線材を冷間圧延した材料を用いてぜんまいに加工し、その後、４００～６２０℃で真空中または無酸化雰囲気中で時効処理する。



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【特許請求の範囲】
【請求項１】　加工硬化及び時効硬化型Ｃｏ－Ｎｉ基合金を用いることを特徴とするぜんまい。
【請求項２】　組成は重量比でＣｏ３０～４０%、Ｎｉ２７～３６%、Ｃｒ１２～２６%、Ｍｏ８～１３%、Ｍｎ、Ｔｉ、Ａｌ、Ｆｅの１種または２種以上各０．１～３%、Ｎｂ０．５～３%、ミッシュメタル０．００５～０．０５%、及び不可避不純物から成るＣｏ－Ｎｉ基合金を用いることを特徴とするぜんまい。
【請求項３】　組成は重量比でＣｏ３０．９～３７．２%、Ｎｉ３１．４～３３．４%、Ｃｒ１９．５～２０．５%、Ｍｏ９．５～１０．５%、Ｍｎ０．１～０．５%、Ｔｉ０．３～０．７%、Ｆｅ１．１～２．１%、Ｎｂ０．８～１．２%、ミッシュメタル０．０１～０．０２%、及び不可避不純物より成るＣｏ－Ｎｉ基合金を用いることを特徴とするぜんまい。
【請求項４】　請求項２、３いずれか一項記載のＣｏ－Ｎｉ基合金を、断面減少率で表わされる最終加工度３０～９０%に冷間線引した線材を冷間圧延した材料を用いることを特徴とするぜんまい。
【請求項５】　組成は重量比でＣｏ３０～４０%、Ｎｉ２７～３６%、Ｃｒ１２～２６%、Ｍｏ８～１３%、Ｍｎ、Ｔｉ、Ａｌ、Ｆｅの１種または２種以上各０．１～３%、Ｎｂ０．５～３%、ミッシュメタル０．０１～０．０２%、及び不可避不純物より成るＣｏ－Ｎｉ基合金を用いてぜんまいを製造する工程において、少なくとも焼鈍工程、冷間線引工程、冷間圧延工程、幅断ち工程、エッジ研磨工程、切断工程、成形工程、時効処理工程、溶接工程、テフロン蒸着工程を有することを特徴とするぜんまいの製造方法。
【請求項６】　組成は重量比でＣｏ３０．９～３７．２%、Ｎｉ３１．４～３３．４%、Ｃｒ１９．５～２０．５%、Ｍｏ９．５～１０．５%、Ｍｎ０．１～０．５%、Ｔｉ０．３～０．７%、Ｆｅ１．１～２．１%、Ｎｂ０．８～１．２%、ミッシュメタル０．０１～０．０２%、及び不可避不純物より成るＣｏ－Ｎｉ基合金を用いてぜんまいを製造する工程において、少なくとも焼鈍工程、冷間線引工程、冷間圧延工程、幅断ち工程、エッジ研磨工程、切断工程、成形工程、時効処理工程、溶接工程、テフロン蒸着工程を有することを特徴とするぜんまいの製造方法。
【請求項７】　請求項５、６いずれか一項記載のぜんまいの製造工程において、焼鈍した線材を引き抜きダイスを用いて逆張力伸線機で線引加工することによる断面減少率で表わされる最終加工度３０～９０%に冷間線引した線材を用意する工程を有することを特徴とするぜんまいの製造方法。
【請求項８】　請求項５、６いずれか一項記載のぜんまいの製造工程において、時効処理工程は４００～６２０℃の温度で真空中または無酸化雰囲気中で処理すること

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を特徴とするぜんまいの製造方法。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は、小型精密機器例えば腕時計の動力ぜんまいとその製造方法に関するものである。
【０００２】
【従来の技術】腕時計の動力ぜんまいは高い出力トルクと耐久性、耐食性を要求されるため、その材料には高弾性および高耐食性材料のＣｏ基合金が使用される。
【０００３】
【本発明が解決しようとする課題】ぜんまいの出力トルクは次の式で表される。
$T = Ebt^3\pi N / 6L$
Ｔ：出力トルク
Ｅ：材料のヤング率
ｂ：ぜんまいの幅
ｔ：ぜんまいの厚さ
Ｎ：ぜんまいの有効巻数
Ｌ：ぜんまいの長さ
ぜんまいの厚さ、幅を増さずに高い出力トルクを得るにはヤング率の高い材料を使用すればよいが、従来使用されているＣｏ基合金のヤング率は２００００～２１００００ｋｇｆ／ｍｍ²であり、これよりも高いヤング率を有する耐久性、耐食性に優れた腕時計用動力ぜんまい材料が求められていた。
【０００４】
【課題を解決するための手段】前記課題を解決するために本発明においてぜんまいの材質を、高い機械的強度とヤング率、優れた耐久性および耐食性を有するＣｏ－Ｎｉ基合金とした。このＣｏ－Ｎｉ基合金とは、例えば、組成は重量比でＣｏ３０～４０%、Ｎｉ２７～３６%、Ｃｒ１２～２６%、Ｍｏ８～１３%、Ｍｎ、Ｔｉ、Ａｌ、Ｆｅの１種または２種以上各０．１～３%、Ｎｂ０．５～３%、ミッシュメタル０．００５～０．０５%、及び不可避不純物から成るＣｏ－Ｎｉ基合金を示す。
【０００５】ここでＣｏ３０～４０%、Ｎｉ２７～３６%を含むＣｏ－Ｎｉ基合金に限定した理由は、切欠けもろさがなく、機械的強度、疲労強度、耐食性、加工性に優れているからである。Ｃｏが３０%未満では機械的強度が低下し、Ｃｏが４０%を越えると硬くなり冷間加工性が低下し不適当である。
【０００６】Ｎｉを２７～３６%とした理由は機械的強度と加工性を維持する最適範囲を示すことによる。ＦｅもＮｉと同様の効果があるが、耐食性を低下させないためにこの範囲にしてある。Ｃｒ１２～２６%、Ｍｏ８～１３%の理由は、Ｃｏ、Ｎｉを含有した条件において耐食性を有する最適範囲を示し、この下限未満では耐食性が劣り、この上限を越えると冷間加工において硬くなり

加工困難になるため不適当であることによる。Mnは脱酸剤としての効果及び溶体化処理に際してマトリクスの軟化を助ける。Alは脱酸剤としての効果及び機械的強度を高める効果がある。Tiは結晶粒微細化の効果がある。Nbは機械的強度を更に高める効果があるが、3%を越えると硬くなり過ぎ不適当である。ミッシュメタルは熱間加工性を良くする効果がある。

【0007】この合金を真空溶解にて溶製し、鍛造、熱間圧延、熱間線引、溶体化処理、冷間線引、焼鈍の後、断面減少率で表わされる最終加工度30～90%に冷間線引する。この合金は硬くて変形抵抗が大きいので引き抜きダイスを用いて逆張力伸線機で線引する。その線材をぜんまいの所定厚さに冷間圧延する。ここで線材を圧延するのは、これにより材料の圧延方向が結晶のヤング率の高い方向に揃い、ぜんまいの出力トルクを更に高くすることができるからである。

【0008】線引最終加工度を30%以上としたのは、材料の圧延方向が結晶のヤング率の高い方向にそろい、ゼンマイの出力効果をさらに高くするという効果が現れる下限値を示しており、線引最終加工度を90%以下と＊

＊したのは、加工度がこれより高くなるとぜんまいの靭性が低下してもろくなるからである。このようにして仕上げた圧延材を所定幅に幅断ちし、エッジ研磨、切断、成形、時効処理、溶接、テフロン蒸着の各工程を経てぜんまいに仕上げる。時効処理は400～620℃の温度で2～3時間真空中または無酸化雰囲気中で行う。

【0009】図1に腕時計用動力ぜんまいの形状例を、また図2にぜんまいの製造工程の例を示す。

【0010】

【作用】前記のような構成により、高い出力トルクを有し、耐久性と耐食性に優れたぜんまいを得ることができる。

【0011】

【実施例】Co－Ni基合金（合金A）と従来使用のCo基合金（合金B）とを用いて腕時計用動力ぜんまいに加工して特性の比較を行った。表1と表2に夫々合金Aと合金Bの組成を示す。また表3に合金Aと合金Bのヤング率を示す。

【0012】

【表1】

(wt%)

	C	M.M.	Mn	Ni	Cr	Mo	Nb	Ti	Co	Fe
合金 A	≦0.03	0.01 ～ 0.02	0.1 ～ 0.5	31.4 ～ 33.4	19.5 ～ 20.5	9.5 ～ 10.5	0.8 ～ 1.2	0.3 ～ 0.7	30.9 ～ 37.2	1.1 ～ 2.1

M.M.：ミッシュメタル

【0013】　※　※【表2】

(wt%)

	C	Si	Mn	Ni	Cr	Mo	W	Ti	Al	Co	Fe
合金 B	≦0.03	0.8 ～ 1.05	0.5 ～ 1.1	16.0 ～ 17.0	11.6 ～ 12.2	3.8 ～ 4.2	3.85 ～ 4.15	0.4 ～ 0.8	0.04 ～ 0.12	38.0 ～ 39.4	20.0 ～ 25.0

【0014】

【表3】

	ヤング率（kg／mm²）
合金 A	24000
合金 B	20500

以後合金A製ぜんまいを本発明ぜんまい、合金B製ぜんまいを比較ぜんまいと称することにする。各合金を真空溶解にて溶製し、鍛造、熱間圧延、熱間線引、溶体化処理、冷間線引、焼鈍の各工程を経た後、超硬製の引き抜きダイスを用いて逆張力伸線機で常温で最終加工度60%の線引加工を行い、線径3mmの線材にした。その線材を常温で厚さ0．12mmに圧延し、幅0．95mmに幅断ちした後、エッジ研磨を行った。

【0015】次に370mmの長さに切断して成形加工し、ぜんまい端部に外掛けを溶接した。その後500℃で2時間真空中で時効処理し、最後に表面にテフロンを真空蒸着してぜんまいに仕上げた。このぜんまいを香箱車に挿入しぜんまいの特性を調べた。香箱車の内径は10．60mm、巻き芯径は2．80mmである。

【0016】図3にぜんまい1が香箱車3に挿入された状態を示す。図中の符号2はゼンマイの外掛け、符号4は香箱芯である。表4に各ぜんまいの出力トルク$T_{0.5}$（ぜんまいをいっぱいに巻き上げてから0．5時間分ほどけた状態での出力トルク）、出力トルクT_{24}（24時間分ほどけた状態での出力トルク）、持続時間に関係する巻き数Nを示す。表4からわかるように、本発明ぜんまいは比較ぜんまいに比べ$T_{0.5}$で15%、T_{24}で18%出力トルクが高くなっている。またこのことは、同じ出力トルクのぜんまいであれば、本発明ぜんまいは比較

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ぜんまいに比べぜんまい厚さを薄くできるので、限られた香箱車のスペース内でぜんまいの巻き数を増やすことができ、時計の持続時間を伸ばすことができる。

【００１７】

【表４】

特性 / 試料	$T_{0.5}$ (g－cm)	T_{24} (g－cm)	N (巻)
本発明ぜんまい	７７．０	６３．４	７．０
比較ぜんまい	６６．８	５３．６	７．０

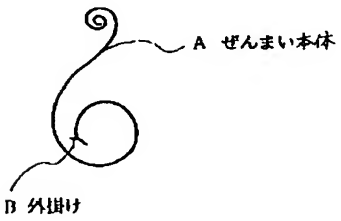
次にぜんまいの耐久性を調べるためにぜんまいの全巻き締め全巻き戻しを繰り返す加速試験を行い、ぜんまいが破断するまでの繰り返し数を調べた。表５に本発明ぜんまいと比較ぜんまいの破断までの繰り返し数を示す。本発明ぜんまいは比較ぜんまいに比べ破断までの繰り返し数が多く耐久性に優れていることがわかる。また本発明ぜんまいは材料組成を見てもわかるように、ＣｒとＭｏを多量に含むので耐食性も非常に優れている。

【００１８】

【表５】

特性 / 試料	破断までの繰り返し数 (回)
本発明ぜんまい	１３５６
比較ぜんまい	１０９８

【図１】



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＊【００１９】

【発明の効果】以上説明したように、本発明ぜんまいは出力トルクが高く、耐久性、耐食性に優れているため、小型精密機器に使用して最適であるという大きな効果がある。

【図面の簡単な説明】

【図１】腕時計用動力ぜんまいの形状例を示す図である。

【図２】ぜんまいの製造工程の例を示す図である。

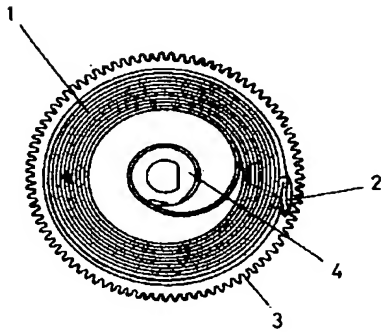
【図３】腕時計用動力ぜんまいが香箱車に挿入された状態を示す図である。

【符号の説明】

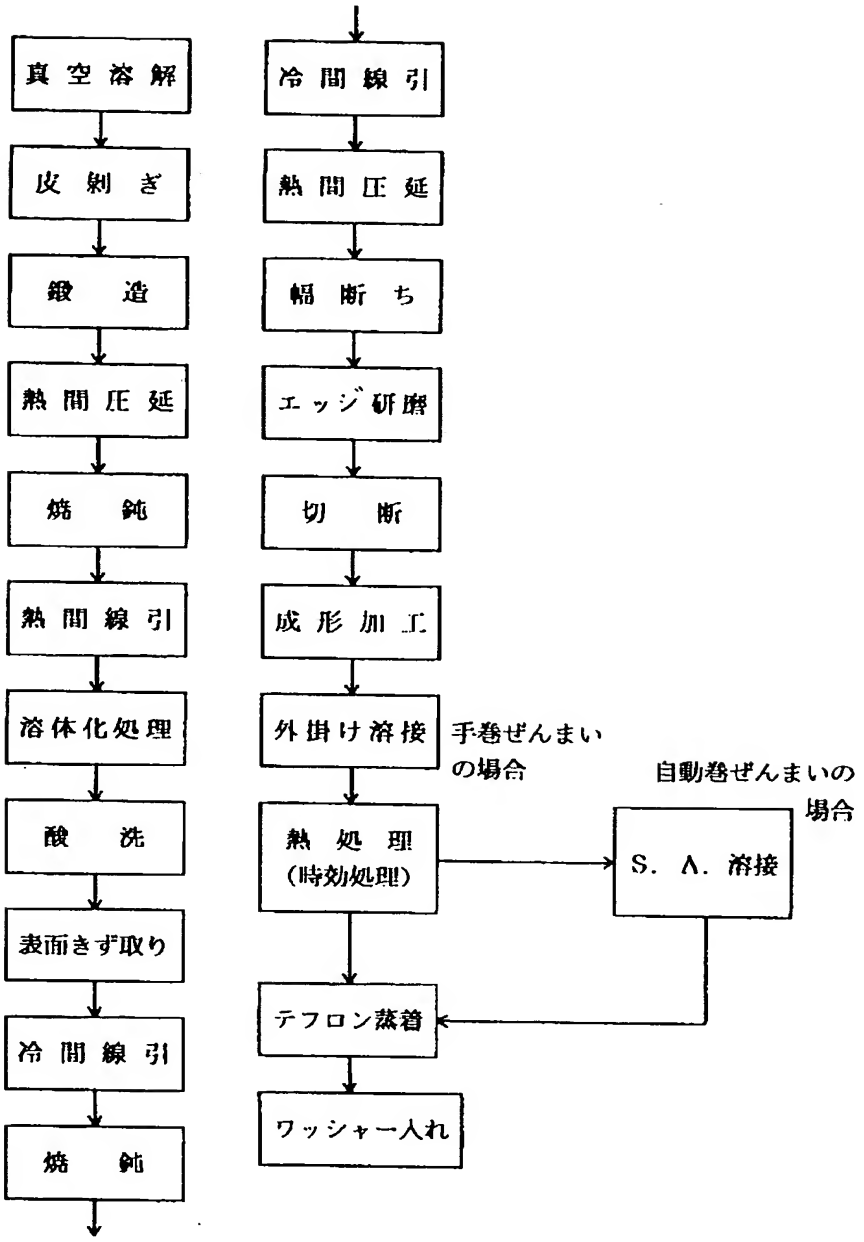
A　ぜんまい本体
B　外掛け
1　ぜんまい本体
2　外掛け
3　香箱車
4　巻き芯

＊

【図３】



【図2】



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